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EX56a STUDY OF EXTENDED X-RAY EMISSION AROUND ISOLATED GALAXIES

EX56b IDENTIFICATION AND SPECTRA OF BRIGHT X-RAY SOURCES AT HIGH
GALACTIC LATITUDE

NASA GRANT NAG8-522

Final Report

For the Period 1 April 1985 through 30 November 1986

Principal Investigator
Dr. Daniel A. Schwartz

January 1987

Prepared for:

National Aeronautics Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Smithsonian Institution
Astrophysical Observatory
Cambridge, Massachusetts 02138

The Smithsonian Astrophysical Observatory
is a member of the
Harvard-Smithsonian Center for Astrophysics

The NASA Technical Officer for this grant is Dr. W.G. Johnson, Code ES01,
NASA, George C. Marshall Space Flight Center, Marshall Space Flight Center,
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FINAL REPORT

1. Scientific Investigations

The present contract has partially supported efforts by the PI to participate in analysis of EXOSAT Observations. Many observing proposals were approved by the EXOSAT Committee for Observation Proposal Selection (COPS) in response to the AO-2 and AO-3, and carried out by EXOSAT. I served as PI of the following proposals:

1. "Study of Extended X-ray Emission Around Isolated Galaxies."
2. "Identification and Spectra of Bright X-ray Sources at High Galactic Latitude."

I was a co-investigator on the following proposals:

3. "New Observations of Unusual or Luminous Active Galactic Nuclei," (PI: R. Remillard).
4. "Observations of H0323+023 - An Unusual BL Lac Object," (PI: H. Bradt).
5. "X-ray Observations of Be Star Binaries," (PI: M.G. Watson).
6. "Observations of Two New X-ray Emitting Cataclysmic Variables," (PI: I. Tuohy).
7. "Complete Identifications of a Complete Flux Limited (2-10 keV) X-ray Sample," (PI: A. Lawrence).
8. "Further EXOSAT Observations of the Unusual BL Lac H0323+023," (PI: H. Bradt).
9. "Observations of the Cataclysmic Variable 0540+60," (PI: R. Remillard).

In addition to the present grant, research based on these observations was also partially supported at SAO by NASA contract NAS8-30453 and NASA grant NAG8-496, and by an award from the Smithsonian Institution Scholarly Studies

program. Additional support was also obtained by collaborators at MIT and at the Australian National University.

2. Summary of Results

EXOSAT observations confirmed the identification and extended nature of PKS 2354-35. It gave a good 2-10 keV X-ray spectrum, and a detailed spatial profile indicating asymmetry of the structure. We can clearly deduce that this is an accretion flow system. A talk was given at the 168th AAS meeting announcing this discovery, and a paper is in progress.

In our high galactic latitude investigation, we detected the BL Lac object identified with the HEAO-1 source 1430+423, and obtained the first X-ray spectrum of it. This has been reported in a talk, and a publication in preparation. We detect 0422-086 as an extended source of X-rays, with a thermal spectrum of $kT = 3.7$ keV, and therefore identify it with a cluster of galaxies. H2322-269 is within 5 arcsec of a $V = 5.8$ star of type G5. This is puzzling since we would not expect coronal emission to be detectable, nor do we expect ultraviolet contamination (but cannot rule it out). Seven other fields are blank, which we attribute (in order of most to least probable) to error in the NRL catalog position, low energy absorption, or source variability.

In our studies of H0323+022 we have obtained several simultaneous observations (organized by H. Bradt) over a broad range of the electromagnetic spectrum. We did not observe any unusual or dramatic short time scale observations; however, we will report these results as part of the synoptic record of this object.

Studies of luminous active galactic nuclei have given significant information on the spectrum of the quasar PKS 0558-504. This is much steeper than the "standard" 0.7 index for Seyfert galaxies. We are intrigued by a possible connection with the "I Zw 1" nature of this galaxy (very strong FeII, narrow permitted, weak forbidden lines, generally radio weak). We hypothesize that the fundamental relation is with the X-ray spectrum, and not with the radio loud vs. quiet nature of the object. This was presented (by R. Remillard) at the 169th AAS meeting, and a publication is in progress.

In a study of Southern sky cataclysmic variables, we used EXOSAT to determine X-ray spectra and search for periodicities in two objects. H0542-407 does have X-ray periodicities and is a member of the DQ Her class (so-called "intermediate polar," a white dwarf with strong magnetic field but with spin and orbit periods slightly asynchronous). H0534-581 is also best explained as a DQ Her. Both results have been published and presented at meetings (by collaborators I. Tuohy and D. Buckley).

Studies of complete identifications have revealed that X-ray sources in two high galactic latitude fields are stars, and therefore are to be excluded from the Piccinotti extragalactic sample. Only one Piccinotti source remains to be identified.

3. Publications

The following publications and talks have made use of our EXOSAT data.

"The Discovery of Eight Bright Active Galactic Nuclei Observed with the HEAO-1 Scanning Modulation Collimator," Remillard, R.A., Bradt, H.V., Buckley, D.A.H., Roberts, W., Schwartz, D.A., and Wood, K. 1986, Ap.J., 301, 742.

"Identification of Two Southern X-ray Emitting Cataclysmic Variables," Tuohy, I.R., Buckley, D.A.H., Remillard, R.A., Bradt, H.V., and Schwartz, D.A. 1986, Ap.J., (in press).

"H0323+022: Classification as a BL Lac and EXOSAT Coordinated Observations," Bradt, H.V., Schwartz, D.A., et al. 1985, Space Sci. Rev., 40, 613.

"Optical Observations of New X-ray Emitting Cataclysmic Variables," Tuohy, I.R., Buckley, D.A., Remillard, R.A., Bradt, H.V., and Schwartz, D.A. 1985, Proc. of Bamberg Cataclysmic Variable Workshop. ESA SP-236, 73.

"Newly Discovered BL Lacertae Objects Identified as Bright X-ray Source Counterparts by the HEAO-1 Scanning Modulation Collimator," Schwartz, D.A., Roberts, W., Murray, S., Huchra, J., Remillard, R., Bradt, H.V., McClintock, J., Tuohy, I., Buckley, D., Tapia, S., Feigelson, E., and Schmelz, J. 1985, [Abstract] B.A.A.S., 17 608.

"Optical Observations of New X-ray Emitting Cataclysmic Variables," Buckley, D.A., Tuohy, I.R., Remillard, R.A., Bradt, H.V., and Schwartz, D.A. 1985 [Abstract], B.A.A.S., 17, 589.

"EXOSAT Study of the Accretion Flow Galaxy PKS2354-35, Identified with 4U0009-33 by the HEAO-1 Modulation Collimator," Schwartz, D.A., Bradt, H.V., Remillard, R., Buckley, D., Tuohy, I. 1986, [Abstract], B.A.A.S., vol. 18, 707.

"Two X-ray Selected BL Lac Objects Observed with the HEAO-1 Scanning Modulation Collimator," Remillard, R.A., Buckley, D.A.H., Schwartz, D.A., Tapia, S., and Tuohy, I.R. 1987, Ap.J., (to be submitted).

"The Steep X-ray Spectra of the QSO's PKS0558-504 and I Zw1," Remillard, R.A., Schwartz, D.A., and Bradt, H.V. 1986, [Abstract], B.A.A.S., vol.18, 915. (Also, publication for Ap.J., in preparation).